FINAL REPORT

EXECUTIVE SUMMARY

I-40 West Corridor Profile Study

California State Line to Junction I-17

PREPARED FOR ADOT MARCH 2017

ADOT WORK TASK NO.
MPD 072C-14

ADOT CONTRACT NO.
11-013152

Prepared by

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ARIZONA DEPARTMENT OF TRANSPORTATION

PREPARED BY:

IN ASSOCIATION WITH:

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EXECUTIVE SUMMARY

INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of the western portion of Interstate 40 (I-40) between the California State Line and Interstate 17 (I-17). This study examines key performance measures relative to the I-40 West corridor, and the results of this performance evaluation are used to identify potential strategic improvements. The intent of the corridor profile program, and of ADOT's Planning-to-Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT is conducting eleven CPS within three separate groupings. The I-40 West corridor, depicted in **Figure ES-1**, is one of the strategic statewide corridors identified and the subject of this CPS.

Corridor Study Purpose, Goals and Objectives

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

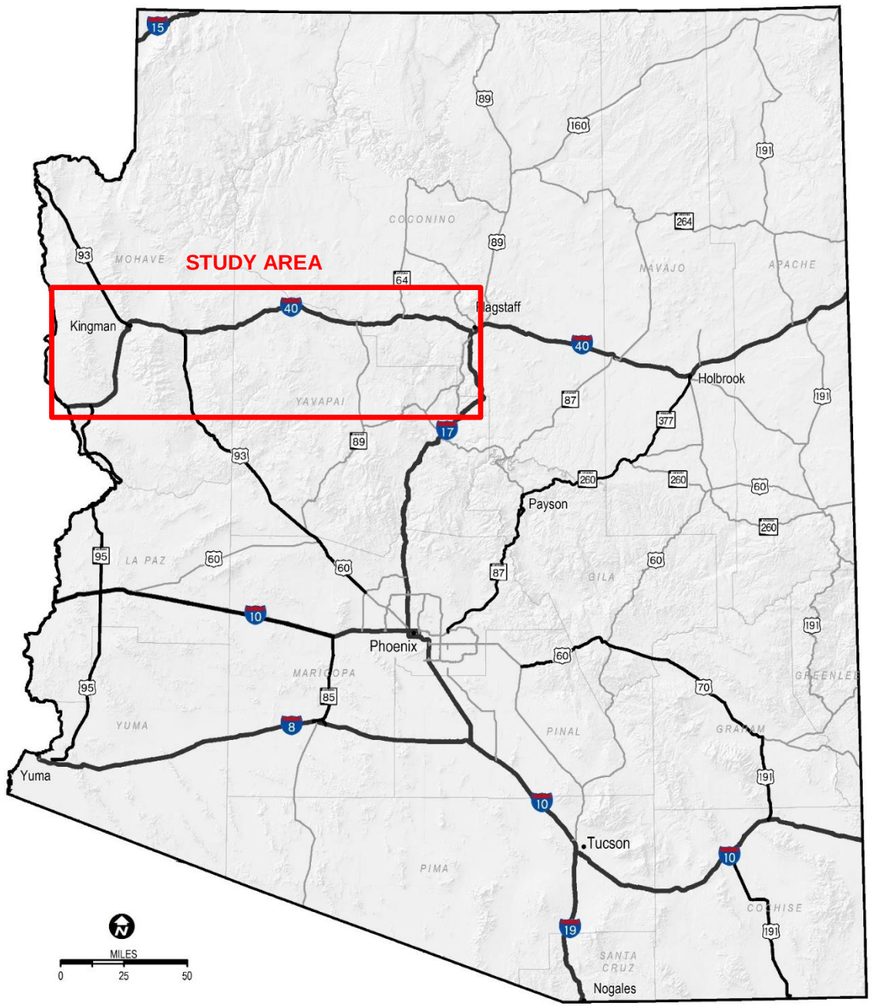
- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The I-40 West CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.

The following goals are identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

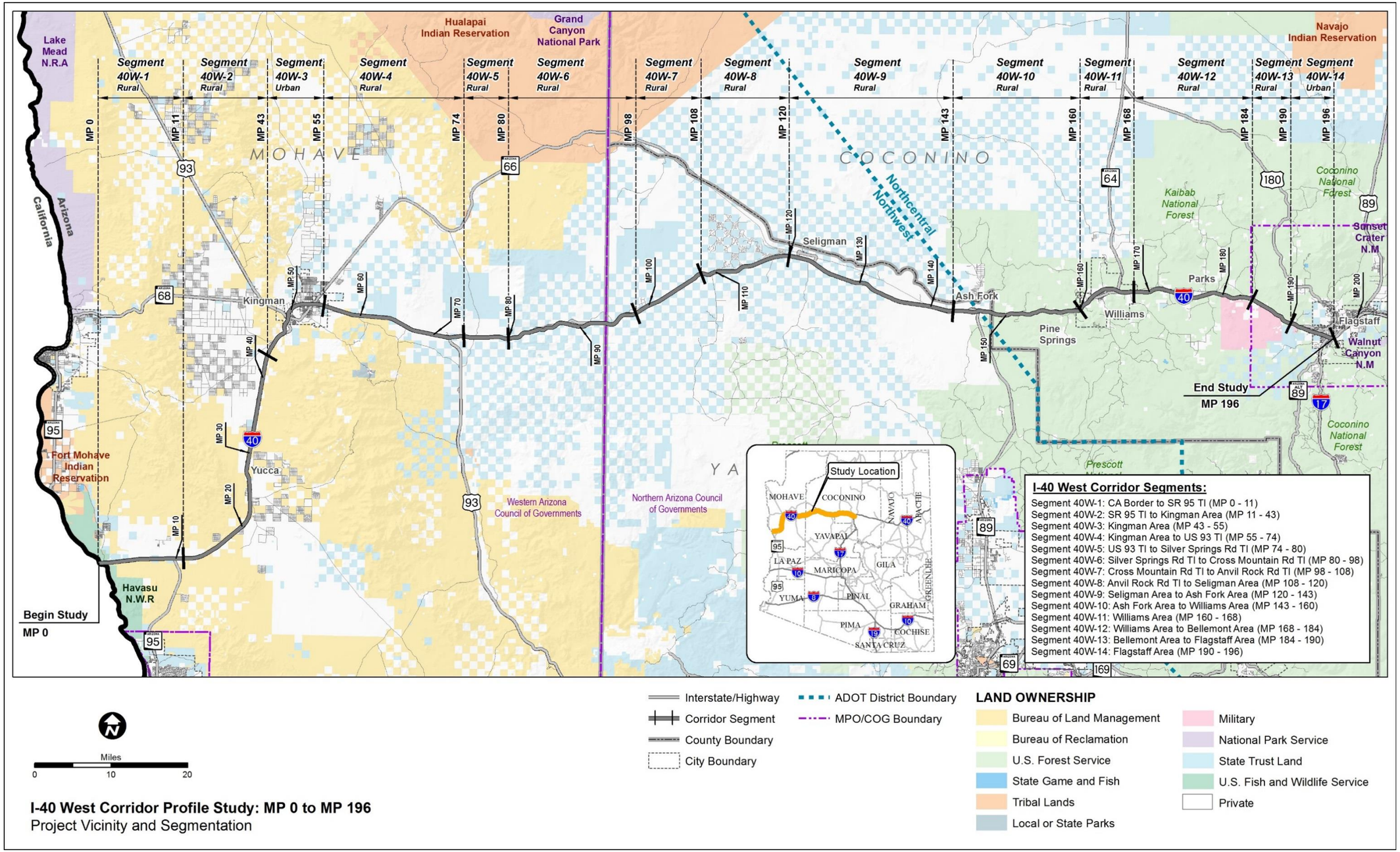
Figure ES-1: Corridor Study Area



Study Location and Corridor Segments

The I-40 West corridor is divided into 14 planning segments for analysis and evaluation. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are shown in **Figure ES-2**.

Figure ES-2: Corridor Location and Segments



I-40 West Corridor Profile Study: MP 0 to MP 196
Project Vicinity and Segmentation

CORRIDOR PERFORMANCE

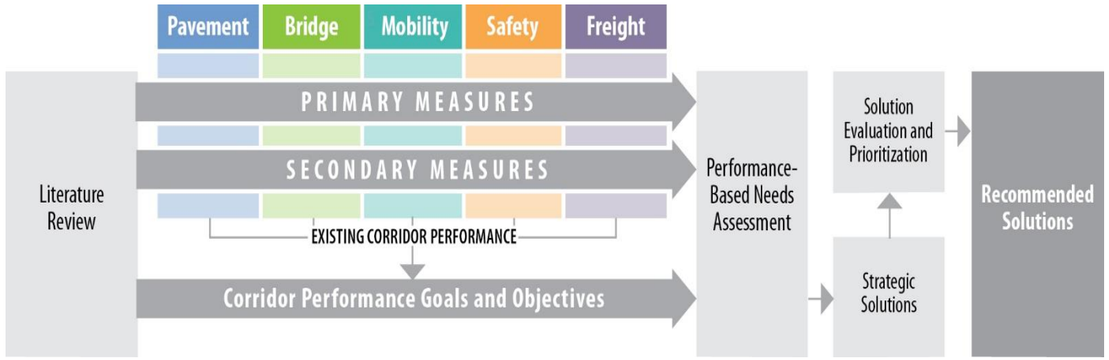
A series of performance measures is used to assess the I-40 West corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

Figure ES-3 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance.

Figure ES-3: Corridor Profile Performance Framework



The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance. **Table ES-1** provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table ES-1: Corridor Performance Measures

Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index and cracking	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Functionally Obsolete Bridges • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and incapacitating injury crashes	• Directional Safety Index • Strategic Highway Safety Plan Emphasis Areas • Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck planning time index	• Recurring Delay • Non-Recurring Delay • Closure Duration • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

Each of the primary and secondary performance measures identified in the table above is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance – Rating is above the identified desirable/average range

Fair/Average Performance – Rating is within the identified desirable/average range

Poor/Below Average Performance – Rating is below the identified desirable/average range

The terms “good”, “fair”, and “poor” apply to the Pavement, Bridge, Mobility, and Freight performance measures, which have defined thresholds. The terms “above average”, “average”, and “below average” apply to the Safety performance measures, which have thresholds referenced to statewide averages.

Corridor Performance Summary

Table ES-2 shows a summary of corridor performance for all primary measures and secondary measure indicators for the I-40 West corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure as shown in **Table ES-2**.

Based on the results of the performance evaluation, the following general observations were made related to the performance of the I-40 West corridor:

- Overall Performance: The Pavement, Mobility, and Freight performance areas show generally "good" performance; Bridge and Safety performance areas show generally "poor/below average" or "fair/average" performance
- Pavement Performance: The weighted average of the Pavement Index shows "good" performance for the I-40 West corridor; exceptions include Segments 40W-4 and 40W-13, which show "poor" performance for the Pavement Index; the weighted average of % Area Failure shows "poor" performance for the corridor; all segments except Segments 40W-3 and 40W-7 have Pavement hot spots
- Bridge Performance: The weighted average of the Bridge Index shows "fair" performance along the I-40 West corridor; the Bridge index predominantly shows "fair" performance, with the exception of Segments 40W-1 and 40W-7, which show "poor" and "good" performance, respectively, the weighted average for Lowest Bridge Rating shows "poor" performance for the corridor; all segments except Segments 40W-3, 4, 7, 11, and 13 have Bridge hot spots
- Mobility Performance: The weighted average of the Mobility Index shows "good" performance throughout the I-40 West corridor; the EB Closure Extent, EB Directional TTI, and EB/WB Directional PTI all show "fair" performance; the % Non-SOV Trips shows "poor" performance for the corridor along with many individual segments
- Safety Performance: The weighted average of the Safety Index shows "average" performance for the I-40 West corridor; performance measures for crashes involving motorcycles and non-motorized travelers had insufficient data to generate reliable performance ratings; several segments had insufficient data to generate reliable performance ratings for crashes involving trucks or behaviors associated with the SHSP Top 5 Emphasis Areas; the weighted averages show "average" performance for the Directional Safety Index and crashes involving trucks or behaviors associated with the SHSP Top 5 Emphasis Areas; Segments 40W-3 and 40W-10 have Safety hot spots
- Freight Performance: The weighted average of the Freight Index shows "good" performance along the I-40 West corridor; Closure Duration shows "poor" performance for Segments 40W-4 through 40W-14 in the EB direction, including the weighted corridor average, and for Segments 40W-10 through 40W-12 in the WB direction; no Freight hot spots exist along the corridor
- Lowest Performing Segments: Segments 40W-1, 40W-10, and 40W-11 have "poor/below average" performance for many performance measures
- Highest Performing Segments: Segments 40W-7, 40W-9, and 40W-14 have "good/above average" performance for many performance measures

Table ES-2: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area				Bridge Performance Area				Mobility Performance Area											
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
			EB	WB								EB	WB	EB	WB	EB	WB	EB	WB		
40W-1[b2]	11	4.10	4.03	4.12	5%	3.66	81.10	5.7%	3	0.28	0.39	0.18	0.18	0.15	0.05	1.23	1.10	1.56	1.28	98%	9.8%
40W-2[b2]	32	4.38	4.29	4.21	2%	5.78	90.49	5.9%	4	0.29	0.40	0.19	0.19	0.16	0.09	1.12	1.09	1.29	1.22	50%	10.7%
40W-3[a1]	12	4.11	4.06	4.04	0%	5.80	95.02	19.1%	5	0.41	0.53	0.27	0.27	0.28	0.12	1.22	1.14	1.72	1.56	92%	19.0%
40W-4[b2]	19	3.20	3.10	3.48	48%	5.59	93.41	24.4%	5	0.19	0.16	0.19	0.19	0.37	0.17	1.16	1.15	1.69	1.54	100%	12.5%
40W-5[b2]	6	3.64	4.15	3.20	33%	5.13	94.85	21.0%	4	0.28	0.38	0.13	0.13	1.40	0.00	1.27	1.20	1.68	1.57	100%	6.2%
40W-6[b2]	18	3.20	3.41	3.22	54%	5.36	87.52	3.4%	4	0.25	0.34	0.13	0.12	1.20	0.12	1.24	1.10	1.64	1.27	100%	6.8%
40W-7[b2]	10	3.94	3.84	3.95	0%	6.72	95.52	0.0%	6	0.27	0.37	0.15	0.15	1.06	0.00	1.13	1.08	1.31	1.22	100%	6.8%
40W-8[b2]	12	4.09	4.02	3.98	8%	5.71	90.38	49.0%	4	0.29	0.40	0.16	0.15	1.07	0.12	1.09	1.14	1.23	1.37	100%	13.8%
40W-9[b2]	23	4.27	3.93	4.24	2%	5.21	87.19	0.0%	4	0.31	0.42	0.15	0.15	0.89	0.05	1.13	1.12	1.39	1.34	100%	10.8%
40W-10[b2]	17	3.64	3.50	3.55	48%	5.37	91.34	40.1%	4	0.31	0.43	0.13	0.13	0.71	0.59	1.31	1.16	1.98	1.65	100%	12.3%
40W-11[b2]	8	3.26	3.54	3.63	31%	5.81	95.07	23.5%	5	0.32	0.44	0.14	0.14	0.55	0.30	1.16	1.12	1.40	1.36	100%	8.1%
40W-12[b2]	16	3.60	3.76	3.94	9%	5.27	80.51	79.7%	5	0.30	0.38	0.14	0.14	0.45	0.25	1.11	1.13	1.28	1.46	98%	8.3%
40W-13[b2]	6	2.85	3.73	3.52	42%	5.50	97.11	0.0%	5	0.34	0.43	0.21	0.21	0.53	0.23	1.11	1.12	1.30	1.33	98%	12.4%
40W-14[a1]	6	3.73	3.87	3.73	28%	5.11	90.05	0.0%	4	0.51	0.67	0.27	0.27	0.53	0.13	1.04	1.14	1.20	1.36	99%	16.1%
Weighted Corridor Average		3.81	3.81	3.84	20%	5.53	91.23	17%	4.35	0.30	0.39	0.17	0.17	0.62	0.16	1.17	1.12	1.48	1.38	91%	10.9%

SCALES

Performance Level	Interstate			All				Urban and Fringe Urban	All	Uninterrupted		All	
Good/Above Average	> 3.75	> 3.75	< 5%	> 6.5	> 80	< 12%	> 6	< 0.71	< 0.22	< 1.15	< 1.3	> 90%	> 17%
Fair/Average	3.20 - 3.75	3.20 - 3.75	5% - 20%	5.0 - 6.5	50 - 80	12% - 40%	5 - 6	0.71 - 0.89	0.22 - 0.62	1.15 - 1.33	1.3 - 1.5	60% - 90%	11% - 17%
Poor/Below Average	< 3.20	< 3.20	> 20%	< 5.0	< 50	> 40%	< 5	> 0.89	> 0.62	> 1.33	> 1.5	< 60%	< 11%

Performance Level	Rural
Good/Above Average	< 0.56
Fair/Average	0.56 - 0.76
Poor/Below Average	> 0.76

[a]Urban 4 Lane Freeway
[b]Rural 4 Lane Freeway with Daily Volume < 25,000

[1]Urban Operating Environment
[2]Rural Operating Environment

Table ES-2: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area							Freight Performance Area							
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/milepost/year/mile)		Bridge Vertical Clearance (feet)
			EB	WB						EB	WB	EB	WB	EB	WB	
40W-1[b2]	11	1.35	1.34	1.35	70%	Insufficient Data	Insufficient Data	Insufficient Data	0.80	1.12	1.06	1.33	1.17	23.11	9.82	16.17
40W-2[b2]	32	1.00	1.19	0.81	65%	24%	Insufficient Data	Insufficient Data	0.87	1.05	1.03	1.16	1.13	42.11	22.21	16.14
40W-3[a1]	12	1.26	1.47	1.06	37%	11%	Insufficient Data	Insufficient Data	0.75	1.14	1.04	1.47	1.18	51.27	17.52	16.25
40W-4[b2]	19	1.75	1.46	2.04	32%	24%	Insufficient Data	Insufficient Data	0.71	1.11	1.10	1.48	1.33	154.41	24.21	16.25
40W-5[b2]	6	0.67	0.08	1.26	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.73	1.17	1.10	1.42	1.32	741.13	0.00	No UP
40W-6[b2]	18	1.59	1.36	1.81	45%	18%	Insufficient Data	Insufficient Data	0.78	1.15	1.03	1.42	1.15	686.31	46.59	16.00
40W-7[b2]	10	1.20	1.52	0.88	20%	Insufficient Data	Insufficient Data	Insufficient Data	0.86	1.07	1.03	1.21	1.13	641.44	0.00	16.65
40W-8[b2]	12	0.26	0.27	0.24	23%	15%	Insufficient Data	Insufficient Data	0.87	1.02	1.07	1.11	1.19	637.78	15.95	16.56
40W-9[b2]	23	0.67	0.85	0.49	35%	12%	Insufficient Data	Insufficient Data	0.82	1.06	1.05	1.24	1.18	458.46	13.70	16.00
40W-10[b2]	17	2.09	1.22	2.96	44%	20%	Insufficient Data	Insufficient Data	0.64	1.23	1.09	1.69	1.45	374.77	491.32	16.27
40W-11[b2]	8	0.93	0.92	0.93	75%	Insufficient Data	Insufficient Data	Insufficient Data	0.80	1.08	1.06	1.26	1.23	202.70	285.30	16.20
40W-12[b2]	16	0.33	0.13	0.54	25%	0%	Insufficient Data	Insufficient Data	0.81	1.05	1.07	1.16	1.29	216.38	247.11	16.17
40W-13[b2]	6	0.55	0.91	0.19	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.84	1.05	1.04	1.19	1.18	217.40	101.72	17.30
40W-14[a1]	6	0.32	0.60	0.04	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.83	1.03	1.10	1.15	1.27	204.27	34.33	16.27
Weighted Corridor Average		1.08	1.02	1.14	43.5%	16.6%	Insufficient Data	Insufficient Data	0.80	1.09	1.06	1.31	1.22	308.92	93.06	16.22

SCALES										
Performance Level	**Urban 4 Lane Freeway**					**Uninterrupted**			**All**	
Good/Above Average	< 0.79	< 49.1%	< 6.8%	< 9.3%	< 4.8%	> 0.77	< 1.15	< 1.3	< 44.18	> 16.5
Fair/Average	0.79 - 1.21	49.1% - 59.4%	6.8% - 10.9%	9.3% - 11.5%	4.8% - 10.3%	0.67 - 0.77	1.15 - 1.33	1.3 - 1.5	44.18 - 124.86	16.0 - 16.5
Poor/Below Average	> 1.21	> 59.4%	> 10.9%	> 11.5%	> 10.3%	< 0.67	> 1.33	> 1.5	> 124.86	< 16.0
Performance Level	**Rural 4 Lane Freeway with Daily Volume < 25,000**									
Good/Above Average	< 0.73	< 42.8%	< 13.2%	< 5%	< 1.7%					
Fair/Average	0.73 - 1.27	42.8% - 52.9%	13.2% - 17.0%	5% - 8.5%	1.7% - 2.5%					
Poor/Below Average	> 1.27	> 52.9%	> 17.0%	> 8.5%	> 2.5%					

[a]Urban 4 Lane Freeway
[b]Rural 4 Lane Freeway with Daily Volume < 25,000
[1]Urban Operating Environment
[2]Rural Operating Environment

Notes: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings
"No UP" indicates no underpasses are present in the segment

NEEDS ASSESSMENT

Corridor Description

The I-40 West corridor is and will continue to be a major transportation corridor for intrastate and interstate commerce, intercity travel, and tourism. I-40 is designated by ADOT as a strategic highway corridor, a key commerce corridor, and part of the National Primary Freight Network.

Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP), 2010-2035. Statewide performance goals that are relevant to I-40 West performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three "emphasis areas" were identified for the I-40 West corridor: Pavement, Bridge, and Safety.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

Needs Assessment Process

The performance-based needs assessment evaluates the difference between the baseline performance and the performance objectives for each of the five performance areas used to characterize the health of the corridor: Pavement, Bridge, Mobility, Safety, and Freight. The performance-based needs assessment process is illustrated in **Figure ES-4**.

The needs assessment compares baseline corridor performance with performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown in **Figure ES-5**.

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. A detailed review of available data helps identify contributing factors to the need and if there is a high level of historical investment.

Figure ES-4: Needs Assessment Process

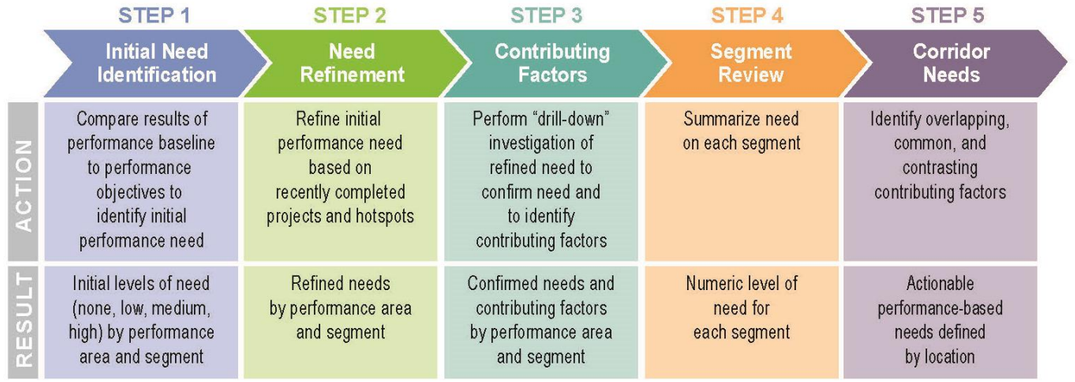


Figure ES-5: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
6.5	Good	None*	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
	Fair		
5.0	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Summary of Needs

Table ES-3 provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Pavement, Bridge, and Safety for the I-40 West corridor). There are no segments with a High average need, eleven segments with a Medium average need, and three segments with a Low average need. More information on the identified final needs in each performance area is provided below.

Pavement Needs

- Overall Pavement needs are Low or None throughout the corridor except for Segment 40W-11 and Segment 40W-13, which have High levels of need; both segments with High levels of need will be addressed by programmed improvement projects
- Twelve segments contain Pavement hot spots, but all of these except for three segments (40W-1, 40W-2, and 40W-14) have been addressed by recently completed projects, will be addressed by programmed improvement projects, or are segments that have not experienced high levels of historical investment
- Through a field review, a review of previously completed geotechnical reports, and discussions with ADOT District staff, it has been determined that there are likely sub-surface issues at the hot spots in Segment 40W-1 at milepost (MP) 3-4 and in Segment 40W-14 at MP 195-196, and that the limits of the hot spots should be expanded to MP 3-8 in Segment 40W-1 and to MP 191-196 in Segment 40W-14 to address the historical Pavement needs in the area

Bridge Needs

- Overall Bridge needs are High for Segments 40W-1, 5, and 12 and Medium for Segments 40W-8, 9, 13, and 14
- Sixty-six of the 149 bridges on the corridor exhibit needs in the Bridge performance area; approximately 50% of the bridges with needs have programmed improvement projects
- Ten bridges are both hot spots and bridges identified in the historical review; these bridges are in Segments 40W-1, 2, 8, 10, and 14

Mobility Needs

- Overall Mobility needs are Low throughout the corridor; there are no programmed projects to address identified Mobility needs
- Mobility needs are primarily related to an above average frequency of full freeway closures, likely due to weather and incidents, or related to a below average planning time index (PTI), likely due to grades, congestion, incidents, and weather

Safety Needs

- Overall Safety needs are High for Segments 40W-1, 4, 6, and 10 and Medium for Segments 40W-2, 3, 7, and 11; there are no programmed projects that are anticipated to fully address identified Safety needs
- Safety hot spots are in Segment 40W-3 at MP 48-51 EB/WB and in Segment 40W-10 at MP 157-158 WB
- Crashes involving single vehicles travelling at speeds too fast for conditions, overturned vehicles, fixed objects, and/or roadway departures exceed the statewide average crashes for similar operating environments on the majority of the I-40 West corridor
- Truck-involved crashes comprise over 24 percent of total crashes between MP 11-43 in Segment 40W-2; crashes in this segment typically involve distracted or inattentive drivers, road departures, fixed object, and overturning

Freight Needs

- Overall Freight needs are Low throughout the corridor except for Segment 40W-4, which has a Medium need, and Segment 40W-10, which has a High need; there are no programmed projects to address identified Freight needs
- Freight needs are primarily related to an above average duration of full freeway closures, likely due to weather and incidents, or related to a below average truck PTI, likely due to grades, congestion, incidents, and weather
- There are no Freight hot spots on the I-40 West corridor

Overlapping Needs

This section identifies overlapping performance needs on the I-40 West corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- A majority of the segments on the I-40 West corridor shows some level of need in four out of the five performance areas
- Segment 40W-1 and Segment 40W-10 have High levels of need in two performance areas: Safety and Freight
- Segments 40W-4, 11, and 13 have a High level of need in one performance area and a Medium level of need in another performance area

Table ES-3: Summary of Needs by Segment

Performance Area	Segment Number and Mileposts (MP)													
	40W-1	40W-2	40W-3	40W-4	40W-5	40W-6	40W-7	40W-8	40W-9	40W-10	40W-11	40W-12	40W-13	40W-14
	MP 0-11	MP 11-43	MP 43-55	MP 55-74	MP 74-80	MP 80-98	MP 98-108	MP 108-120	MP 120-143	MP 143-160	MP 160-168	MP 168-184	MP 184-190	MP 190-196
Pavement[+]	Low	Low	None	None	None	Low	None	Low	Low	None	High	Low	High	Low
Bridge[+]	High	Low	Low	Low	High	Low	None	Medium	Medium	Low	Low	High	Medium	Medium
Mobility	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Safety[+]	High	Medium	High	High	Low	High	Medium	Low	None	High	Medium	None	None	None
Freight	Low	Low	Low	Medium	Low	Low	Low	Low	Low	High	Low	Low	Low	Low
Average Need	**1.92**	**1.23**	**1.23**	**1.38**	**1.23**	**1.46**	**0.77**	**1.23**	**1.00**	**1.54**	**1.69**	**1.23**	**1.46**	**1.00**

Average Need Scale	
None[*]	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

[+] *Identified as an emphasis area for the I-40 West corridor*

[*] *A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study*

STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need as addressing these needs will have the greatest effect on corridor performance. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The I-40 West strategic investment areas (resulting from the elevated needs) are shown in **Figure ES-6**.

Screening Process

In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment or rating issues; these hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need; this bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the I-40 West corridor will be considered along with other candidate projects in the ADOT statewide programming process.

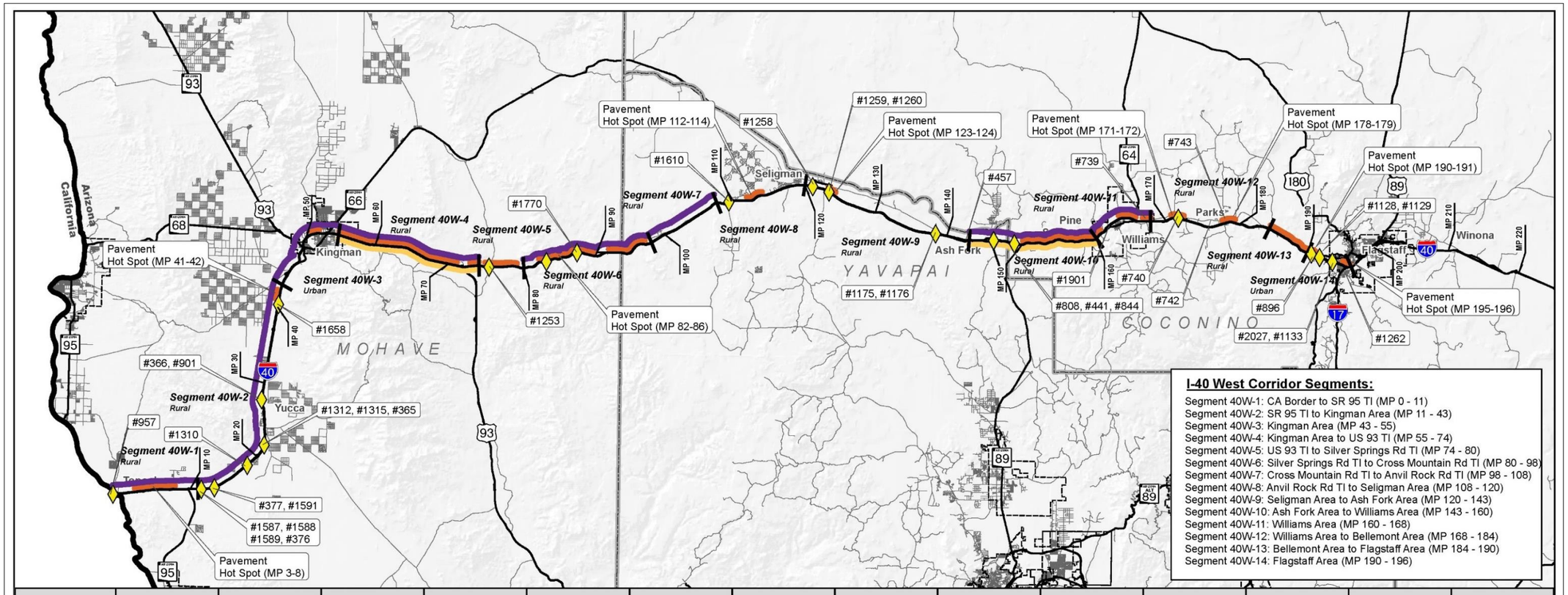
Candidate solutions include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance areas include two options; rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

Figure ES-6: Strategic Investment Areas



Performance Area	40W-1	40W-2	40W-3	40W-4	40W-5	40W-6	40W-7	40W-8	40W-9	40W-10	40W-11	40W-12	40W-13	40W-14
	MP 0-11	MP 11-43	MP 43-55	MP 55-74	MP 74-80	MP 80-98	MP 98-108	MP 108-120	MP 120-143	MP 143-160	MP 160-168	MP 168-184	MP 184-190	MP 190-196
Pavement*	Hotspot	Hotspot	-	-	-	Hotspot	-	Hotspot	Hotspot	-	High	Hotspot	High	Hotspot
Bridge*	High	Hotspot	-	-	High	Hotspot	-	Medium	Medium	Hotspot		High	Medium	Medium
Mobility	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Safety*	High	Medium	High	High	-	High	Medium	-	-	High	Medium	-	-	-
Freight	-	-	-	Medium	-	-	-	-	-	High	-	-	-	-

** Identified as emphasis area for I-40 West corridor*

Note: Figure shows strategic investment areas which are segments with Medium and High levels of need and locations of hot spots. A "-" symbol indicates a segment level of need of Low or None, which is not considered strategic."

I-40 West Corridor Profile Study: MP 0 to MP 196
Strategic Investment Areas

N
Miles
0 10 20

Interstate/Highway
Corridor Segment
County Boundary
City Boundary
#1234 ADOT Structure Number

Performance Area Needs
Pavement
Mobility
Safety
Freight
Bridge

Level of Need
Low
Medium
High

SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation is shown in **Figure ES-7** and described more fully below.

Life-Cycle Cost Analysis

All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

All Mobility, Safety, and Freight strategic investment areas that result in multiple independent candidate solutions are advanced directly to the Performance Effectiveness Evaluation.

Performance Effectiveness Evaluation

After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

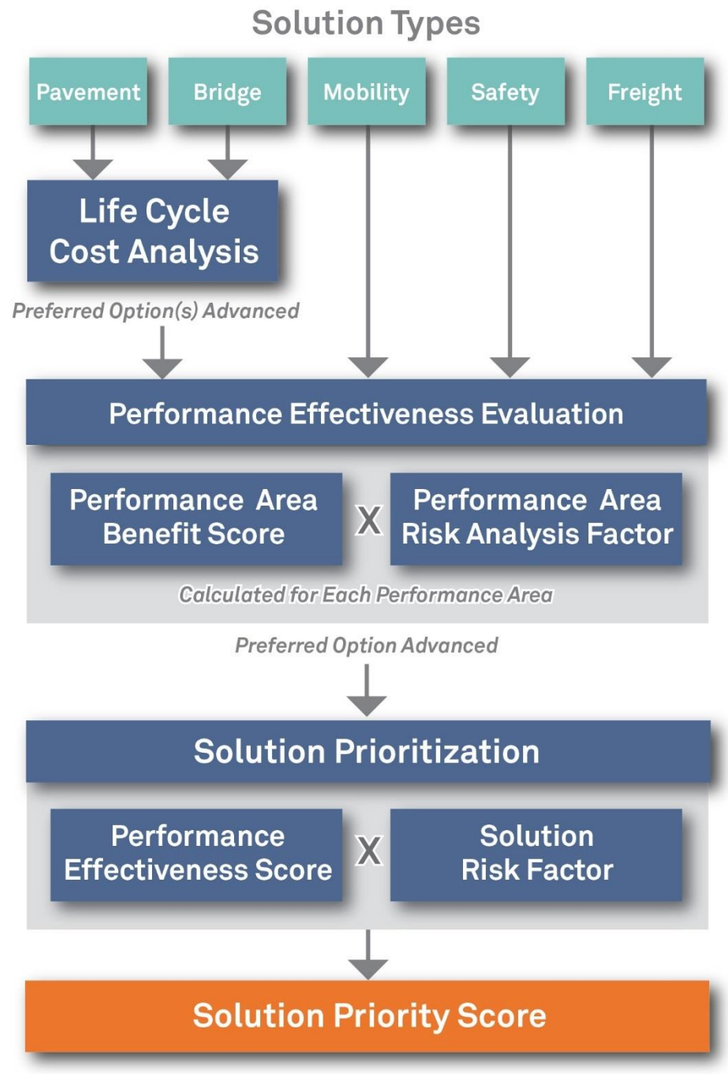
Solution Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of the performance failure.

Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure ES-7: Candidate Solution Evaluation Process



SUMMARY OF CORRIDOR RECOMMENDATIONS

Prioritized Candidate Solution Recommendations

Table ES-4 and **Figure ES-8** show the prioritized candidate solutions recommended for the I-40 West corridor. Implementation of these solutions is anticipated to improve performance of the I-40 West corridor in all five performance areas. The highest priority solutions address needs in the Stateline to Kingman area (MP 0-55) and Ash Fork to Williams area (MP 143-160).

Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor-specific recommendations that are not related to construction or policy. The list below identifies other corridor recommendations for the I-40 West corridor:

- Expand the limits of the programmed pavement rehabilitation project in FY 2019 at MP 108-123 to also include MP 123-124 to address the Pavement hot spot at MP 123-124
- Expand the limits of the programmed pavement rehabilitation project in FY 2018 at MP 162-179 to also include MP 160-162 to address the Pavement hot spot at MP 160-161
- Expand the scope of the programmed bridge deck rehabilitation project in FY 2019 at the W Flagstaff TI WB Bridge #1129 at MP 192 to also include bridge superstructure rehabilitation to address the low superstructure rating at this bridge
- Conduct an interchange operations study for the I-40/SR 95 interchange near MP 10
- Promote planned construction of I-40/US 93 system interchange near MP 49

Policy and Initiative Recommendations

In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through the CPS process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on the I-40 West corridor, but across the entire state highway system where conditions are applicable. The following list, which is in no particular order of priority, was derived from the Round 1, Round 2, and Round 3 CPS:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic messaging signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects; in pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is recommended to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network

Next Steps

Candidate solutions developed for the I-40 West corridor will be considered along with other candidate projects in the ADOT statewide programming process. It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives. Upon completion of all three CPS rounds, the results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.

Table ES-4: Prioritized Recommended Solutions

Rank	Candidate Solution #	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
1	CS40W.3	Stateline to SR 95 Safety Improvements (MP 0-11)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips)	$6.2	M	**64**
2	CS40W.17	Ash Fork to Williams Safety and Freight Improvements (MP 143-160)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement Variable Speed Limits (VSL) at EB/WB MP 151-159 and integrate with existing RWIS at MP 154 and MP 159 and existing DMS at EB MP 144 and with new DMS at WB MP 160	$30.3	M	**58**
3	CS40W.9	Kingman Area Safety Improvements (MP 43-55)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Install median cable barrier at MP 47-51 -Implement VSL at EB/WB MP 47-53 and integrate with existing DMS at EB MP 45 and WB MP 55	$29.0	M	**28**
4	CS40W.5	Illavar Wash EB Bridge #1310 - Replacement (MP 18.30)	-Replace bridge	$1.2	M	**24**
5	CS40W.1	Colorado River Bridge #957 (MP 0)	-Continue coordinating with Caltrans for programming Colorado River Bridge deck replacement; Cost reflects ADOT's anticipated share of costs	$55.0	M	**19**
6	CS40W.7	Griffith Wash WB Bridge #1658 - Replacement (MP 40.42)	-Replace bridge	$2.0	M	**19**
7	CS40W.15	Anvil Rock Rd TI UP Bridge # 1610 - Replacement (MP 108.65)	-Replace bridge	$2.8	M	**18**
8	CS40W.19	Williams Area Safety Improvements (MP 160-168)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 161-163 and integrate with existing RWIS at MP 159 and existing DMS at WB MP 168 and with new DMS at EB MP 160	$12.3	M	**18**
9	CS40W.6	Flat Top Wash WB Bridge #1312 - Replacement (MP 21.01)	-Replace bridge	$2.0	M	**17**
10	CS40W.14	Jolly Road Area Safety Improvements (MP 98-108)	-Rehabilitate shoulder (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 101-104 and integrate with new RWIS at MP 103 and new DMS at EB MP 100 and WB MP 105	$14.5	M	**17**
11	CS40W.4	Franconia Wash WB Bridge #377 - Replacement (MP 13.61)	-Replace bridge	$2.3	M	**16**
12	CS40W.8	SR 95 to Kingman Safety Improvements (MP 11-43)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Provide signs for driver information (advance notice of rest area)	$18.0	M	**8**
13	CS40W.11	Kingman to US 93 Safety and Freight Improvements (MP 58-71)	-Implement VSL at EB/WB MP 58-71 and integrate with existing DMS at EB MP 69 and with new DMS at EB MP 55 and WB MP 72	$47.7	M	**7**
14	CS40W.21	West Flagstaff Pavement Improvements - Replacement (MP 191-196)	-Replace pavement	$43.2	M	**6**

Table ES-4: Prioritized Recommended Solutions (continued)

Rank	Candidate Solution #	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
15	CS40W.2	Topock Area Pavement Improvements - Replacement (MP 3-8)	-Replace pavement	$35.9	M	**4**
16	CS40W.13	Willow Creek Safety Improvements (MP 80-98)	-Construct EB climbing lane at MP 80-83 and MP 93-97 -Widen Echeverria OP EB bridge #1675, MP 94.45 -Widen Cross Mountain TI OP EB bridge #1677, MP 96.02 -Implement VSL at EB MP 80-83, EB MP 88-90, and EB MP 93-97 and integrate with existing RWIS at MP 91 and new DMS at EB MP 79 and WB MP 98	$51.2	M	**4**
17	CS40W.10	Kingman Area Climbing Lane (MP 47-51)	-Construct EB climbing lane MP 47-51 -Widen W Kingman TI OP EB bridge #1835, MP 48.84 -Widen Clack Canyon Wash EB bridge #1837, MP 49.70 -Widen White Cliff Road OP EB bridge #1839, MP 50.09	$25.6	M	**3**
18	CS40W.12	Kingman to US 93 Area Climbing Lane (MP 58-60)	-Construct EB climbing lane at MP 58-60	$7.5	M	**2**
19	CS40W.18	Ash Fork to Williams Area Climbing Lane (MP 151-159)	-Construct EB climbing lane at MP 151-152 and MP 156-159 -Widen Devil Dog TI OP EB bridge #1178, MP 157.71	$22.8	M	**1**
20	CS40W.20	Williams Area Climbing Lane (MP 162-163)	-Construct WB climbing lane at MP 162-163 -Widen SFRR and Cata Lake OP WB bridge #1902, MP 162.38	$5.6	M	**1**

Figure ES-8: Prioritized Recommended Solutions